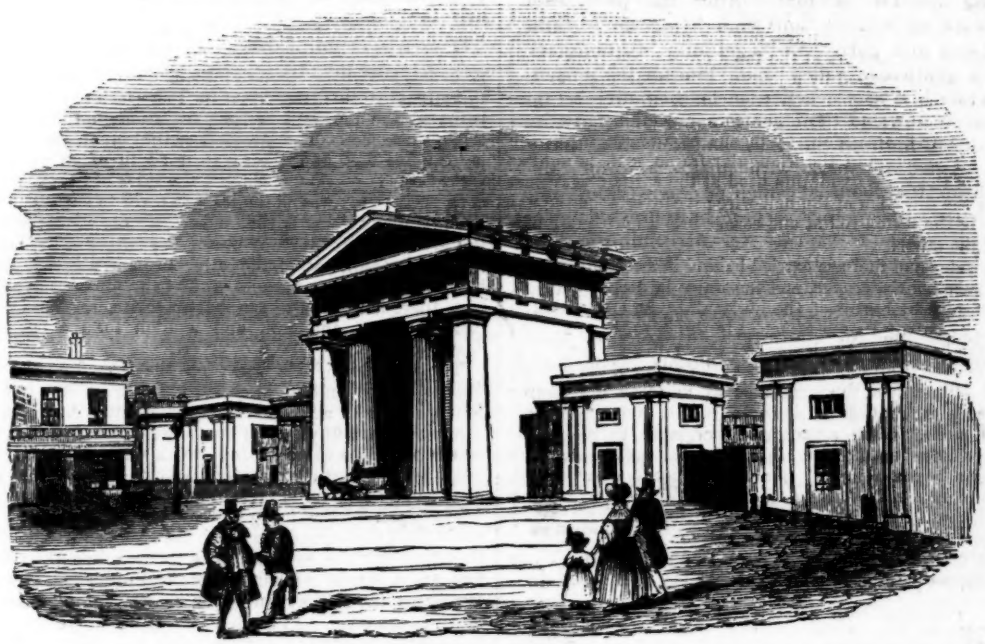
THE

Saturday Magazine.

Nº 502 SUPPLEMENT, APRIL, 1840. { PRICE ONE PENNY.

GLANCES AT RAILROAD TRAVELLING. No. II.



ENTRANCE TO THE LONDON AND BIRMINGHAM RAILWAY, EUSTON SQUARE.

NOTHING will serve better to sober down our judgment of what is *great* or *wonderful* among the productions of man, than a review of what has been done in railroads within the last twelve years. Before that period railroads were looked upon by a large majority of persons as insane, impracticable, and visionary schemes which would never be brought into successful operation, and that a well-built coach driven ten miles an hour was a noble instance of swift travelling. At present, instead of deeming railroad schemes insane, impracticable, and visionary, we regard them as splendid monuments of engineering ability, and as being one among the means by which the social and commercial relations of life may be benefited. Twenty years hence we may perhaps look back with a smile to the time when locomotive carriages travelled on our railroads at the rate of *only* five-and-twenty miles an hour. Such are the changes in our feelings and opinions, when we become accustomed to any particular state of things; this ought to teach us, while we properly appreciate the labours of those who have benefited society at large, not to have a too great fondness for things to which we have become accustomed, to the exclusion of changes which may turn out to be valuable improvements.

We have been led to these remarks by considering the astonishing extent to which railroads have been carried since the completion of that from Liverpool to Manchester. Numerous lines now traverse the country in various directions, and many more are in progress. In the Supplement for October, after a brief account of the origin of railroads, we detailed the history and progress of that from Liverpool to Manchester, with a description of which we concluded. On the present occasion we propose taking a glance at a *portion* of what has been since done; we say a *portion*, for the whole would occupy several Supplements.

The first thing that strikes us is the undisputed establishment of a *steam-engine* as the source of locomotive power. It will be remembered that in the former Supplement we stated that it was only after a series of experiments that the adoption of steam locomotive engines was resolved upon on the Liverpool and Manchester railway. Since that time every railroad has adopted similar locomotive power; and as we did not on the former occasion describe the mode by which the steam-engine is thus applied, we propose to do so now, previous to detailing the progress of other railroads.

RAILROAD LOCOMOTIVE ENGINES.

WE must beg our readers to refer to the Supplement for last May, on Steam Navigation, by which a general idea of the action of the steam engine will be obtained. The Supplement for October will also furnish a few elucidatory details. What we propose at present is to show how the steam-engine is made to turn the *wheels* of a locomotive carriage, as the whole progress of the railroad train depends thereupon.

The figure in page 164 will give a general idea of the appearance of a locomotive engine, such as are now employed on our railroads. We observe a strong cast-iron frame A A, supported on four wheels, of which the two hinder and larger are called the *driving-wheels*. On this carriage rests the *boiler*, B B, which is cylindrical in form, and is made up of plates of wrought iron. The furnace or stove is at the hinder end, and the chimney in front. The former is a cubical iron box, the lower part of which is seen at C; its sides and top are double, containing between them a layer of water about three inches thick, which is constantly replenished by water descending from the boiler; for, as the top of the stove is rather below the level of the water in the boiler, this layer of water is always preserved of the same thickness, and the steam as it is generated passes up into the boiler. The smoke and hot air from the fire escape into a number of small tubes, (of which there are about ninety,) which completely traverse the lower half of the boiler, on their way to the chimney; so that nearly all the heat, smoke, and hot air from the furnace, are turned to the useful purpose of assisting to heat the boiler; and the draught is increased by the waste steam being projected up the chimney. Any pieces of ignited fuel which may be carried up with the draught are prevented from escaping into the air and

doing mischief, by a wire-net capping on the top of the chimney.

At E is the *throttle-valve*, which is moved by the engineer, by the aid of a long rod, FF, so as to regulate the supply of steam, and consequently the speed of the engine. From this valve the steam passes by a large tube into the valve-box, G, and thence into the top or bottom of the cylinder, to work the piston; it then escapes by the pipe H into the chimney. The cylinder in this engine preserves its usual upright position; but in other engines almost every variety of situation and position has been tried for it; it has been placed horizontal, inclined, and vertical, with the piston-rod pointing in various directions.

Of course all the apparatus shown in our figure, on one side only of the boiler, is repeated on the other; so that there are, in fact, two engines, one for each driving-wheel. Each piston-rod, I, bears at the top a cross-piece, from which hangs a rod, connected by a joint at the lower end, to one corner of the moveable iron triangle, K K, whose centre of motion is at L; to the other corner of this triangle is joined the rod, M, which, by means of a crank, works the wheel. The action of the triangular frame, K K, is similar to that of the brass quadrants used at the corners of rooms, to alter the direction of the bell-wire; it converts the vertical motion of the piston-rod at one corner into a horizontal motion at the other.

The water and fuel are carried behind in the first carriage, which is called the *tender*, and the water is drawn through the feed-pipe by means of the horizontal pump, P, which is worked by having its rod attached to the triangle at K. At N are the handles of two levers, by which the course of the steam may be so altered as to reverse the action of the engine, and consequently of the wheels, so as to move the engine backwards or forwards at pleasure.

This, then, is the arrangement of parts by which the steam-engine becomes the source of motion to the train moving along a railroad; for it need hardly be said that, when the engine itself is in motion, nothing is more easy than to communicate that motion to a train of carriages, by hooking them to the locomotive carriage.

This, then, being the grand source of motion in all our railroads, we proceed to notice the

LONDON AND BIRMINGHAM RAILWAY.

THE bill for empowering a company to construct a railroad from London to Birmingham met with a very powerful opposition in the House of Commons, in 1832; it, however, passed through that house, but was rejected by the House of Lords. In the following session the projectors were more successful; and the bill received the royal assent in May, 1833.

The capital which the shareholders were empowered to raise among themselves, by subscriptions of 100*l.* per share, was 2,500,000*l.*, a sum which, according to the calculations made by the engineers, would greatly exceed the outlay. That engineers make gross mistakes sometimes in their estimates of the probable expense of a great undertaking is well known; nor should we be justified in viewing in too severe a light the miscalculations thus made; but rarely has there been an instance in which the expense has exceeded the estimate by so large a sum as is the case with respect to the London and Birmingham railway. In February last the directors drew up a report, in which the total amount of money received was 5,276,457*l.* 5*s.* 8*d.*; of which had been expended 5,018,816*l.* 16*s.* 3*d*! The expense of obtaining the act of Parliament alone was above seventy thousand pounds; and the price paid for land and compensation to inhabitants, &c., was more than six hundred thousand pounds. The extra capital required, beyond that allowed by act of Parliament, has been provided for by means of loans, taken upon debentures at a favourable rate of interest, charged on the general income of the company.

The works were commenced in June, 1834; and by July, 1837, twenty-four and a half miles at the London end were opened to the public; on October the 16th, in the same year, it was opened to Tring, thirty-one miles and three-quarters; on April the 9th, 1838, to Denbigh Hall, forty-eight miles, and from Birmingham to Rugby, twenty-nine miles. Finally, on the 20th of August, 1838, a large party of directors and shareholders left the Birmingham station at half-past six in the morning, and travelled along the whole extent of the railroad to London, performing the whole distance of 110 miles in five hours; and on the 17th of September it was opened to the public.

Before we ask the reader to accompany us in a trip along the railroad, we will say something of its general construction. The line commences at Euston-square, and passes near Harrow, *Watford*, Boxmoor, Berkhamstead, *Tring*, *Leighton*, *Wolverton*, Roade, Blisworth, *Weedon*, Crick, *Rugby*, Brandon, *Coventry*, Hampton, to *Birmingham*; there are stations at all these places, those in italics being first class stations. There were originally to have been eleven *tunnels*, but the number has been reduced to eight; viz., the Primrose Hill, 1164 yards; Kensall Green, 322 yards; Watford, 1719 yards: Northchurch, 345 yards; Linslade, 372 yards; Stowe Hill, 418 yards; Kilsby, 2398 yards; and Beechwood, 600 yards. The greatest width of the tunnels within the walls is twenty-four feet; the greatest height above the rails twenty-two feet: in most of the tunnels the shafts, or vertical openings, originally made for working the tunnels, are the same now used for ventilation.

An approximation to a level for the railway was obtained, as usual, by cutting through hills, and using the earth taken therefrom to form embankments. The width of the embankment on the top, and of the excavation on the bottom, is thirty-three feet. The greatest height of an embankment is forty-five feet, and the greatest depth of an excavation sixty-five. The greatest slope of the sides of the excavations is as twelve to four, and the least as three to four. The number of embankments is 130, and of cuttings about the same; the greatest length of any one of the former being about a mile and a half, and of the latter two and a half. At the bottom of each embankment, and at the top of each excavation, there is a space of ten feet on each side, to allow of a hedge, a post and rail, and a ditch for the purpose of draining.

The most formidable works on the line, from the great difficulties encountered in quicksands, water, &c., were the Kilsby tunnel, and the Blisworth cutting, which last averaged about fifty feet in depth for two miles, and from which 1,200,000 cubic yards of earth were taken. The total quantity of earth excavated along the line is about 15,000,000 cubic yards averaging 120,000 per mile.

The span of the bridge where the turnpike and other roads pass *under*, and the width between the parapet where they pass *over* the railroad, is in no case less than fifteen feet, and the arch is about sixteen feet in height. In some few cases the railway passes on a *level* across a road not much frequented. In such cases gates are erected, and policemen stationed; the gates being so contrived as to close either across the railway or across the road. When a railroad train is approaching, the gates are closed across the road; and as soon as the train has passed, the gates are shut across the railway, and the communication by the road again opened. In order to give notice to the policeman of the approach of a train, the engineer sometimes makes use of a steam whistle, which consists of a pipe or whistle attached to the engine, and through which steam from the boiler is allowed to pass, thus producing a similar (but more powerful) effect to the blowing by means of the breath.

We must now leave the mere formation of the road-way, and shortly speak of the very important subject of the *rails*. The reader must not suppose that the iron rails merely lie along the ground, with a slight mode of fastening: on the contrary, the preparatory arrangements are both extensive and difficult. The rails are supported by iron *chairs*, and the chairs are fixed either to wooden *sleepers* or stone *blocks*. Considerable difference of opinion has existed, and still exists, as to the relative merits of stone blocks and wooden sleepers; but we believe that in the railway now under our consideration both are used, blocks in the excavation and on the smaller embankments, and sleepers on the large embankments. The sleepers are made principally of larch and oak, and are nine feet long, nine inches wide, and five inches deep. These pieces of wood are arranged lengthwise, end to end, one row under each rail. In those parts where these sleepers are not employed, their place is supplied by stone blocks, two feet long, the same in width, and one foot deep,—some of these fifteen inches deep. They are arranged in a direction diagonal to the rails; and the distance from centre to centre of the blocks varies from two feet and a half to four feet. The stone blocks for the whole line have been estimated at 152,460 tons weight, costing 180,000*l.*; the expense being pretty nearly divided into three parts, viz., one third for the cost of stone, one third for the freight from the quarries to the Thames, and one third for delivery on various parts of the works.

On the blocks and sleepers are fixed cast-iron chairs or pedestals, of an average weight of about twenty-five pounds each. They are fixed to the *blocks* by drilling two holes in

each block, into which oak trenails, or plugs, are driven, and a spike inserted through them and the chairs; a piece of felt being placed between each chair and block. The chairs are attached to the *sleepers* by a couple of pins or spikes.

The *rails* are the continuous iron bearing, on which the wheels run. From Euston Square to Camden Town there are four double lines of rails; and two double lines for the remainder of the distance. The *sidings*, or passing-places, with the rails at the stations, &c., increase the total length of railway to 125 miles. The width of each double line of way is five feet, and the central space between the lines, six feet. The rails are made of malleable iron. The rails originally laid down on the Liverpool and Manchester line, and which weighed thirty-five pounds to the yard, were found insufficient to bear the enormous traffic passing over them. Those of the London and Birmingham have therefore been made more massive: ten miles of road are laid with fish-belly rails, (so called from the convex form of their lower edge) at fifty pounds to the yard: twenty-five miles with parallel rails, at sixty-five pounds to the yard; and the remainder with parallel rails, at seventy-five pounds to the yard. The rails are raised above the ground rather more than an inch; and the weight of iron used for the whole is about 35,000 tons, which cost the company 460,000*l.*

The *inclinations*, or changes of level along the railroad, have been influenced by the natural formation of the ground: here are five ridges or hilly districts, separated by six valleys, between London and Birmingham. These ridges and valleys had to be made as nearly level as could conveniently be done, by excavating the one and carrying a raised embankment across the other. Still however an exact level is rarely attained, the distance being regulated as follows:—thirteen miles are level; fifty-one and three quarters are at inclinations varying from one to fourteen feet per mile; and forty-six and three quarters are at inclinations between fourteen and sixteen feet per mile. The general nature of the level may be judged from the following table:—

Distance from Station at Euston Square.	*Name of Place.*	*Height above the Sea.*
Miles.		Feet.
1¼	Camden Town station	129
3¼	Brent Valley	112
14¼	Oxhey ridge, near Watford	240
16¾	Colne Valley	229
31¼	Tring Valley	420
54¼	Ouse Valley	259
60¼	Blisworth ridge, near Northampton	388
65¾	Nen Valley	319
77¼	Kilsby ridge, near Daventry	395
91¼	Avon Valley	320
98¼	Reaves Green ridge, near Coventry	377
102¼	Blythe Valley	263
112¼	Birmingham station	368

The Birmingham station is thus nearly 250 feet higher that at London. In proceeding from London to Birmingham, fifty-five miles are ascending, forty-four descending, and thirteen level.

The remainder of our notice of this splendid undertaking may be chiefly comprised in a glance at the principal objects along the route.

The London terminus of the railway is in every way worthy of it. It consists of a noble Doric gateway, resembling the entrance to a temple: the height to the top of the pediment is seventy feet, to which the other dimensions of the gateway are proportional. There are various gates on each side of the grand gateway, for the entrance of vehicles, &c. A station at Euston Square did not form part of the original plan, as it was intended to have the terminus at Camden Town; but as it was deemed more convenient to passengers to be set down nearer the heart of town, an extension of the railway was adopted. The Euston Square station, which occupies about seven acres of ground, is devoted to passengers; and the Camden Town station, containing thirty-three acres, is occupied with buildings for engines, wagons, goods, &c., devoted to the carriage or luggage department.

There is a remarkable circumstance connected with the conveyance of a train of carriages from Euston Square, to Camden Town. Although parliament agreed to the extension of the railway to Euston Square, they refused to allow the smoke of locomotive engines to annoy the inhabitants of the houses near which they passed; another plan had therefore to be adopted. The connexion between the two stations is through a deep inclined cutting about a mile in length, walled up on each side, in going through which the carriages pass under several bridges. There is a stationary steam-engine at the top of the inclined plane; and there is an endless rope, 10,000 feet long and seven inches in circumference, which acts upon two large wheels or cylinders, one at the engine, the other at the Euston station. The train of carriages is attached to the rope at the lower end, and upon a given signal, the wheel or cylinder at the upper end is set in rotation, by which the rope is made to traverse the whole distance and back again, much in the same way as the strap that goes round the wheel of a lathe. The two stationary engines, of sixty-horse power each, draw a train up the inclined plane in three minutes. The engines and the rope together cost 25,000*l.* The two lofty and beautifully-formed chimneys at the Camden Town station, belong to the stationary engines employed to work the rope. In proceeding from Camden Town to London, a train descends this inclined plane by the effect of gravity alone.

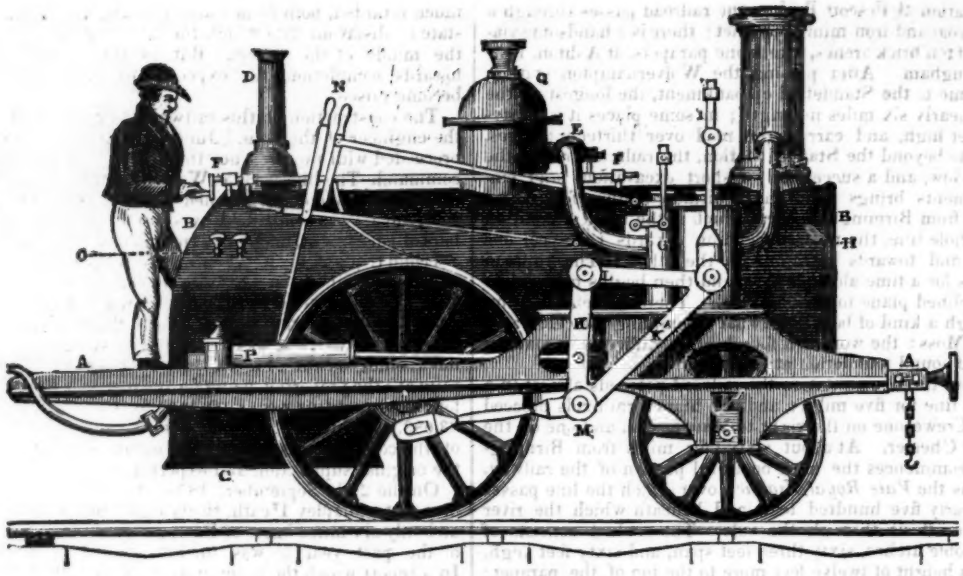
When the train has been drawn up from the Euston station, it is detached from the rope and a locomotive engine, such as we have described, is prefixed to it, and the whole proceed on their journey. The train passes round Chalk Farm, and speedily enters the Primrose Hill tunnel, which is bricked throughout, and ventilated by five capacious shafts. It then crosses the country north of Paddington, to Kensalgreen, where it passes through a short tunnel, ventilated by one shaft. At about the sixth mile-stone, the road becomes level for a mile and a half. A little further on it crosses the river Brent, by a handsome bridge of seven arches. Near Harrow is one of the stations for receiving and putting down passengers, &c.; and at about the eighteenth mile is the Watford station, from which omnibuses convey passengers to Watford for six-pence. The railroad then enters a deep cutting which ends in the Watford tunnel; this is ventilated by five shafts; iron gratings are fixed at the top of the shafts, and high walls built round them, to prevent anything being thrown down from above. After passing near the estates of the Earls of Essex and Clarendon, and the paper-mills of Mr. Dickenson, the train arrives at the station at Boxmoor, twenty-four miles from town.

The next two stations are at Berkhamstead and Tring; on leaving the latter of which the railroad enters a deep excavation, which continues upwards of two miles, passing under three bridges; it is between fifty and sixty feet deep, and occupied four hundred men for three years and a half; in the course of it we pass from Hertfordshire into Buckinghamshire. From thence we proceed to Leighton Buzzard, where there is a station, and also a short tunnel, ventilated by one shaft; which is succeeded by a deep excavation through a hard brown stone.

Denbigh-hall, forty-eight miles from town, was, for about half a year, the limit of the railroad from London; the distance from Denbigh to Rugby being performed by coach on the common roads, and from Rugby to Birmingham by the railroad. After passing Denbigh, the railroad passes between Fenny Stratford on the right, and Stony Stratford on the left, to Blisworth; where there is a cutting two miles long and nearly fifty feet deep, through blue limestone rock: this excavation cost 200,000*l.* We next arrive at Wedon tunnel, which passes obliquely under the ancient Roman Watling Street. At a few miles from this we enter the *magnum opus* of the whole railway, the Kilsby tunnel. Nearly six hundred yards of its length is carried through a quicksand; and the constant use of powerful steam-engines was necessary, in order to keep the water sufficiently under to enable the excavators to continue their work: the cost is estimated at 400,000*l.*

The railroad then reaches Rugby station, within twenty-nine miles of Birmingham; and at about twelve miles distance from thence, Coventry station, the intervening road not calling for any particular notice. A tunnel occurs at Beechwood, near Hampton in Arden, beyond which lie the villages of Sheldon and Yardley. After passing over the high road from Coventry to Birmingham, and also passing the entrance to the Grand Junction railway, we enter the town of Birmingham. The Birmingham station occupies an area of about ten acres, and contains all the requisite conveniences for conducting the passenger and merchandise traffic of the company; although in architectural grandeur the entrance is inferior to that at Euston Square.

The receipts of this noble railway have already reached an extraordinary sum per diem. When it was opened only from London to Tring, the receipts averaged 97*l.* per day; when it was opened from London to Denbigh, and from Birmingham to Rugby, the receipts averaged 821*l.* per day; by the end of August, 1838, they had reached 1000*l.* per day; by December, (the whole line being opened,) they



RAILROAD LOCOMOTIVE ENGINE.

amounted to 1500*l.* per day; by the end of last May, they were about 1800*l.*; and they may now be roundly estimated at 2000*l.* per day.

We may fitly conclude our notice of this railway by a few observations on its economy and management. On a passenger entering the London station, he enters a portico, from which admission is obtained to the pay departments, by separate doors, each door appropriated to a particular class of passenger carriages. These doors are opened about an hour before the starting of each train. The fare is paid to a clerk, who gives a receipt ticket; or, if the fare be paid at any of the booking offices, (of which there are several in London,) and a particularly-coloured ticket given the passenger as a receipt, this ticket being shown at the station will admit the passenger: the receipt tickets are not given up until the end of the journey.

The train of carriages about to depart is drawn up alongside a raised stone platform, protected from the weather by a light handsome shed, supported by cast-iron pillars. At a given signal, when the passengers are seated and the luggage stowed away, the endless rope is attached to the engine, and the train commences its journey. At the various stations along the road, clerks, police inspectors, police constables, porters, and sometimes engineers, are stationed, to facilitate the traffic that may occur at each station. Besides the constables placed at the stations, there are others placed at intervals of about a mile or a mile and a half along the whole extent of the line. Each man is furnished with two flags, red and white, during the day, and a lamp at night, which is made to show either a white, green, or red light: the first announces to the engineer of the approaching train that there is no obstruction to its progress, the green colour directs him to slacken the speed of the train, and the red to stop as soon as possible. The flags answer a similar purpose, except that upon seeing the red one the engineer merely lessens his speed, without stopping. The inspector at each station has a certain number of these men under his orders: they are walking backward and forward on their beat, from half an hour before the passing of the first train in the morning, till after the passing of the last train at night. Watch-boxes are placed at intervals along the line, for the convenience of the constables; and the men are sworn in as county constables, to render their powers more efficient.

Here we must close our notice of this noble undertaking; not from lack of materials, but from a desire of briefly describing one or two others of our great railways.

GRAND JUNCTION RAILWAY.

A RAILROAD from Birmingham to Manchester or Liverpool, or both, is scarcely less important than one from London to Birmingham: because it would become not only the medium of communication between those three important towns, but would also form part of the route from London to Manchester and Liverpool. This circumstance was not lost sight of by railroad projectors, and the Grand Junction railway shows that such a speculation is in every way important.

Although the London and Birmingham railway is the most gigantic, there is a probability that the Grand Junction will excel it as a profitable investment. The engineering difficulties that had to be surmounted were so few, that the cost per mile has been lower than almost any other railway in the kingdom.

In deciding whether this railway should proceed to Manchester or to Liverpool, the happy plan was ultimately adopted of leading it to both, by having its northern terminus at about the middle of the Manchester and Liverpool railway, from which either of those two towns could be reached in thirty or forty minutes. There were three steps by which this has been accomplished. In 1829 an act was obtained for constructing a railway from Warrington to Newton, the central point between Manchester and Liverpool. This is a distance of only four miles and a half, and the capital raised for it was 53,000*l.* In 1833, an act was obtained for a railway from Warrington to Birmingham, under the name of the *Grand Junction Railway*. In 1835, the two companies were incorporated into one, and the whole line, from Birmingham to Newton, obtained the name of the Grand Junction. It is eighty-two miles and a half in length. It commences in Curzon-street, Birmingham, and passes by or near Wednesbury, Walsall, Dudley, Bilston, Wolverhampton, Parkridge, Stafford, Stone, Eccleshall, Newcastle, the Potteries, Nantwich, Sandbach, Middlewich, Northwich, Preston Brook, Frodsham, Runcorn, and Warrington, to Newton; from which, fifteen miles to the right leads to Manchester, and fifteen to the left to Liverpool, by the Liverpool and Manchester railway. From the Newton terminus a farther line of railroad to Lancaster is approaching rapidly towards completion, making altogether a line 237 miles in length from London to Lancaster.

The Birmingham terminus of the Grand Junction is 371 feet above the level of low-water mark at Liverpool, so that a general descent occurs from Birmingham to Newton. From Wolverhampton to Stafford, fifteen miles, there is a fall of 157 feet, or ten feet and a half per mile; from Stafford to Whitmore, fourteen miles, there is a rise of 116 feet, about eight feet per mile; from Whitmore to Warrington, thirty-five miles, there is a descent of 331 feet, nine feet and a half per mile; and from Warrington to Newton, four miles and a half, there is a rise of sixty feet, or nearly thirteen feet per mile. A notable circumstance connected with this railway is, that there is *no* tunnel of any considerable length, a point equally pleasing to engineers, shareholders, and passengers; and what is especially creditable to the engineer is, that the whole undertaking was completed within the estimated expense, viz., a million and a half sterling, less than one third the expense of the London and Birmingham, which is only thirty miles longer.

On leaving the station at Birmingham, the passenger proceeds to the station at Perry Barr, between which and

the station at Pescott Bridge, the railroad passes through a busy coal and iron mining district; there is a handsome viaduct of ten brick arches, with stone parapets, at Ashton, near Birmingham. After passing the Wolverhampton station, we come to the Standeford embankment, the longest on the line, nearly six miles in length; in some places it is thirty-six feet high, and carries the road over thirteen bridges. A little beyond the Stafford station, the railroad crosses the river Sow, and a succession of short excavations and embankments brings us to the Whitmore station, forty-three miles from Birmingham, near which is the highest point on the whole line, the road descending towards Liverpool one way, and towards Birmingham the other. The railroad passes for a time along a level, and then begins to descend an inclined plane to Basford level. There is then a cutting through a kind of bog, somewhat resembling the celebrated Chat Moss: the workmen found great difficulty in making a good sound foundation at this part.

From the Crewe station the railroad proceeds almost in a direct line for five miles; and two branch railroads proceed from Crewe, one on the right to Manchester, and one on the left to Chester. At about sixty-four miles from Birmingham commences the most beautiful portion of the railway. This is the *Vale Royal Viaduct*, over which the line passes for nearly five hundred feet, and beneath which the river Weaver flows through the vale. The viaduct consists of five noble arches, sixty-three feet span, and sixty feet high, with a height of twelve feet more to the top of the parapet; making the total height from the water seventy-two feet. The whole pile contains 250,000 cubic yards of stone, which was brought down the river Weaver in flats and barges. At a distance of four miles from thence we arrive at the very extensive viaduct, crossing the river Weaver and the valley of Dutton; it is more than a quarter of a mile in length, about thirty feet wide, and sixty feet high, and consists of twenty arches, each of sixty feet span. Lastly, at about a mile and a half before reaching Warrington, there is a viaduct of twelve arches, which crosses over the river Mersey, and the Mersey and Irwell canal. The two arches in the centre are seventy-five feet span each, that which crosses the canal is forty feet, and the remaining nine are each sixteen feet and a half span. Near this part of the line is also an excavation a mile and a half in length, over which are thrown five bridges.

The railroad finally terminates at Newton, where it joins the Liverpool and Manchester; and travellers proceed to the right to Manchester, to the left to Liverpool, and on northwards to Wigan, &c., according to their destination.

The railway was opened in July, 1837. The receipts averaged 5000*l.* per week during the first nine weeks. But the ultimate rate of receipt will not be known until the completion of other lines of railway, which will tend to make the distance from London to Manchester or to Liverpool somewhat shorter than by the Grand Junction. There are several railroads in a greater or less stage of advancement about the midland counties of England; but our space will not allow us further to allude to them.

LONDON AND SOUTHAMPTON RAILWAY.

This is the only railroad at all approaching completion, which leads to or near the British Channel. It begins at the south bank of the Thames, at a place called Nine Elms, in the parish of Battersea, a short distance above Vauxhall Bridge, and terminates at the beach of the Southampton water. It will, when completed, pass through, or near, Wandsworth, Wimbleton, Mordon, Kingston, Thames-Ditton, Esher, Walton-upon-Thames, Weybridge, Chertsey, Woking, Farnborough, Odiham, Basing, Basingstoke, Worting, Popham, Mitcheldever, Winchester, Twyford, and Bishop's Stoke. It is at present open from London to Basingstoke, and from Winchester to Southampton, and the remaining portion is rapidly approaching completion.

The capital of the company consisted at first of 1,000,000*l.*, divided into 20,000 shares of 50*l.* each; in addition to which, power was given to the proprietors to borrow on mortgage 330,000*l.*; but these sums proving insufficient for the completion of the work, parliament has sanctioned the creation of 16,000 new shares. The nominal capital of the company, on which dividends will be payable, is 1,800,000*l.* which it is supposed will about complete the whole undertaking.

The course of the line from London to Basingstoke is about west-south-west, and for the remainder of the route, about south-south-west; the entire length will be seventy-seven miles. The progress of this railway was at one time much retarded, both from want of funds, and from a certain state of disfavour into which the undertaking had fallen in the minds of the public. But as the railroad proceeds towards completion, the expectations of its future profit become raised.

The construction of this railway was given to Mr. Locke, the engineer of the Grand Junction Railway, and has been proceeded with rapidly since there were sufficient funds at command. The line as far as Woking Common, twenty-three miles from London, was opened May 21, 1838. On the 12th the Directors, accompanied by several noblemen and members of parliament, made an experimental trip. On the 19th a second trip was made, when nearly 400 persons, principally shareholders in the company, were conveyed along the line. They were in two separate trains, of ten and nine carriages, and travelled at the rate of nearly thirty miles an hour. During the twelve weeks immediately succeeding the partial opening on the 21st, 93,795 passengers travelled on the railway: the proportion being for the first four weeks, 29,127; for the second four weeks, 31,785; for the third four weeks, 33,083. What gave a stimulus to the subsequent exertions of the company was, that these numbers greatly exceeded the original supposition and expectation.

On the 29th September, 1838, the railroad was further opened to Shapley Heath, thirty-eight miles from London, and only six miles short of Basingstoke; and in the summer of the past year it was further opened to Basingstoke. In a report which the proprietors drew up in February 1839, they say:—"On the line between Winchfield and Basingstoke, and also between Winchester and Southampton, the cuttings and embankments are, with very trifling exceptions, completed, and a considerable part of the permanent road is laid down. This will render available about twenty miles more of the line, in addition to the thirty-eight miles already opened, and leave unfinished only the eighteen miles between Basingstoke and Winchester." This increase of length was effected in June last.

The rails for this railway were originally intended to be sixty-three pounds to the yard; but the weight has been since increased to seventy-five pounds. The general nature of the engineering difficulties to be surmounted has probably been less than in the London and Birmingham railway, and more than in the Grand Junction.

Some dissatisfaction has been expressed at the situation of the London terminus at the southern instead of the northern side of the Thames. This is undoubtedly to some extent an inconvenience; but to have crossed the Thames, or even to have brought the terminus into the busy part of Southwark or Lambeth, would have entailed an expense so enormous as would probably have checked the whole affair. The inconvenience is almost entirely removed by the establishment of numerous little iron steam-boats, which proceed from London and other bridges to the station at Nine Elms, by which a passenger is conveyed for four-pence, almost to the door of the station.

In reference to the Southampton railway, a recent writer has observed:—"In connexion with this railway, a plan has been formed and is now in progress for constructing docks at the town of Southampton, with the prospect of its becoming once more a dock of commercial importance This project was conceived under the impression that the railway system would be so far carried out, as to connect the great trade and manufacturing stations of the midland and northern counties with the southern coast, when the advantages as a port of shipment presented by Southampton in preference to London would be sufficiently apparent. It was also imagined that Southampton being brought by means of its railway within three hours and a half (it is thus we must henceforth speak of distances,) of the Metropolis, might become, in some degree the port of London, for ships arriving from and sailing to the westward. Vast as is the consumption of foreign and colonial goods in London, by far the greater part of those goods which now ascend the Thames are distributed afterwards to various, and frequently distant, parts of the country. The anticipated formation of railway lines would allow of this distribution being better made in many cases from Southampton, and it is agreed on all hands that the advantage to the owners of ships from terminating their voyage at Southampton, rather than proceeding through the Straits of Dover to the Thames, would be exceedingly great. The expense, both in time and in money, that would thus be saved would be so much gain to the country at large; and apart even from this consideration, it would appear requisite to look around for means of relieving the Port of London from some part of its con-

stantly growing traffic. The docks, which have been constructed since the beginning of this century, have not had the effect of keeping the course of the river free, so that accidents and loss of life are constantly resulting from its crowded state. Almost every spot adapted for the purpose has already been converted into a dock; and as there is no appearance, and indeed no desire, that the causes which have led to the aggrandizement of the metropolis should cease to operate, the necessity for some such relief as that above mentioned is continually growing more urgent."

It appears to us probable, that if capitalists would venture upon a railroad from Southampton to Bristol, such a line of communication would be established from the British Channel to the northern districts as would, in connexion with the present line from Southampton to London, make the establishment of docks at Southampton a project of great national importance.

We must conclude our notice of the Southampton Railway (whose name has recently been changed to the *South* Western) by stating that the receipts are steadily increasing; and that, although the middle part of the railway is not yet opened, the receipt of money exceeds most of the estimates given at the outset of the undertaking. In the month of June last, the proceeds were as follows:—the week ending June 2, 2219*l.* 14*s.* 0*d.*—week ending June 9, 2200*l.* 13*s.* 0*d.*—week ending June 16, 2762*l.* 1*s.* 0*d.*—and week ending June 23, 2964*l.* 12*s.* 0*d.*

GREAT WESTERN RAILWAY.

No railway has encountered so much opposition, or led to so many conflicting opinions, as the Great Western Railway, intended ultimately to extend from London to Bristol. This has been occasioned by two or three different circumstances,—the very large outlay required, the engineering difficulties to be overcome, and certain modifications which the skilful engineer, Mr. Brunel, has made in the usual modes of proceedings.

An act was obtained in 1835 for making a railroad from London to Bristol. It was at first intended that this line should be connected with the London and Birmingham railway at Kensall Green, four miles and a half from Euston Square; but as certain negociations between the two companies were not satisfactorily terminated, they were broken off, and the new company had therefore to extend their railway to Paddington, where the London terminus now is. From Paddington the line passes either through or near Acton, Ealing, Hanwell, Southall, Slough, Salthill, Maidenhead, Reading, Didcot, Wantage, Farringdon, Swindon, Wotton-Basset, Chippenham, and Bath, terminating in the depôt at Temple-mead, adjoining the floating harbour, at Bristol.

The aspect of the country, with respect to *levels* is this: From London there is a gradual rise in the road to Maidenhead, Reading, and Didcot, by very easy ascents, always within four feet per mile. From Reading to Swindon, the rise is about six feet per mile. There is a level at Swindon, the spot being seventy-six miles from London, 253 feet higher than the Paddington terminus, and 275 feet higher than the Bristol terminus. Between Swindon and Bath, the descent averages about six feet and a half per mile, with the exception of two short inclined planes at Wotton Basset and Box, in which the descent is fifty-three feet per mile. The descent is pretty uniform from Bath to Bristol, at the rate of four feet per mile. Taken altogether, this railroad is considered one of the most favourable in respect to level.

In regard to *tunnels*, it presents one of the most gigantic specimens of engineering, or rather of sheer manual labour, that our railroads have yet exhibited:—we mean the *Box tunnel*. This tunnel had to be excavated for a mile and three quarters through a hard rock, principally of limestone. The tunnel will be thirty feet wide and thirty feet high, and the stone is so firm and compact as to be able to retain the form of the arch without brickwork.

According to the plans sanctioned by the act of parliament there were to have been seven tunnels, amounting together to rather more than four miles in length; but through some deviation in the route, the number has been reduced to five, of which three are between Keynsham and Bristol. There is no tunnel from London to Corsham, a distance of nearly a hundred miles.

One of the important changes which Mr. Brunel has introduced in the construction of this railway, is in the foundation on which the rails are laid. In most railways, the rails are supported at their ends by stone blocks; but Mr. Brunel reccommended the adoption of rails, in pieces fifteen or sixteen feet long, laid on continuous bearings of wood, carefully *Kyanized*, or protected from dry rot, and firmly secured to the ground by piles. The weight of the rails is forty-three pounds per yard, the average weight of those used when stone blocks are employed being sixty-three pounds per yard. The expense attending the original formation of the road upon this plan very much exceeds that of the old method; but the expectation of the engineer is that this excess in the cost will be amply repaid in the first few years of working by the diminution in the cost of repairs.

Another deviation from the usual plan consists in placing the rails seven feet distant, instead of four feet eight inches. It was considered, that being able to place the body of the carriage between the wheels instead of above them as in other instances, wheels of much larger diameter might be employed; by the same arrangement the driving wheels of the engines might also be much enlarged; the advantages derivable from these circumstances were expected to be, that a much higher velocity might be attained: and that increased steadiness and safety would result from the wider basis.

Nothing can exceed the violence with which these "innovations" as they were termed, were received by a portion of the shareholders. The engineer had not only the common engineering difficulties to surmount, but also those arising from the opposition of a portion of his employers. We have neither space nor inclination to discuss all the arguments used on the occasion; but we may fitly give a portion of the report which the directors issued in June, 1838, in answer to some of the objections. The reader will bear in mind that what is here called *packing* means ramming earth or gravel firmly under the longitudinal timbers, on which the rails rest.

"In the first place it may be stated, that one essential part of the operation in constructing the permanent way, is a perfect system of ramming ballast or gravel under the longitudinal timbers, as a means of steady support to them under the pressure of passing trains. It was always stated that the success of the plan depended entirely on this process of packing. It is a matter of general observation, that on some parts of the line, the permanent way firmly resists the pressure of the trains, while on others an uneasy movement prevails. The directors have ascertained, beyond a doubt, that this difference is coincident with those local circumstances which readily account for the defect. Wherever the completion of the rails had enabled the engines to traverse them previously to the opening of the line, (upon which parts, of course, greater time and attention could be bestowed,) the rails answer all the expectations which could reasonably be entertained. The earth under them had been repacked after the engines passed upon the rails; the screws had been tightened with the compression upon them, and the directors consider them to be in a satisfactory state. .....A very uneasy movement in some of the carriages has given rise to a rumour that the plan had totally failed, and the rails must be altered. The directors entertain no such opinion. They are convinced that, as far as the rails are concerned, the remedy can and will be easily administered, by a thorough repacking under the timbers with coarse gravel, which is now in progress, and with a favourable result. It is evident, that in places where sand or light gravel had been used as the material for packing, the resistance was not adequate, and that the substitution of coarse stony gravel has hitherto answered the purpose."

This report failed to satisfy those proprietors who had opposed the great width of the rails, and the continuous timber bearings. The directors therefore appointed two engineers, Mr. Wood and Mr. Hawkshaw, to investigate the whole subject, and report their opinions thereon. Their evidence, given in the month of December, 1838, was very conflicting, but, generally speaking, unfavourable to the system adopted by Mr. Brunel and the directors; amounting, in fact, to a suggestion, that the greater part which had then been done, in respect to rails and bearings, should be undone. It became necessary, therefore, that the directors should come to some definite result. The principal points in dispute were, —the width of the gauge, (that is, the width between the rails), the continuous bearings of wood, the *scantling*, or thickness and depth of the timber, and the employment of wooden piles to support them. On these points, in January of the past year, the directors, "upon a deliberate reconsideration of all the circumstances affecting the permanent welfare of the undertaking, divesting the question of all personal partialities, or obstinate adherence to a system, unanimously acquiesce in the abandonment of the piles, in the substitution of a greater scantling of timber, and of a

heavier rail; retaining the width of gauge, with the continuous timber bearings, as the most conducive to the general interests of the company."

On this determination being read at a public meeting of the share-holders, it was moved, "That this meeting, deeply sensible of the disastrous consequences inevitably arising from repeated discussions as to the principles acted on in carrying on the work, do request the directors to adhere to the principles laid down in the report, as most conducive to the permanent welfare of the proprietors." To this proposition an amendment was proposed, "That the reports of Mr. Wood and Mr. Hawkshaw contain sufficient evidence, that the plans of construction pursued by Mr. Brunel are injudicious, expensive, and ineffectual for this professed object, and ought not to be persevered in." On a division, 7792 votes were given for the report, and 6145 against it.

Thus ended a contest which did considerable injury in many ways to the undertaking. However, the permanent timber bearings and the great width of the gauge are retained, and future experience must decide the question of their superiority over stone blocks and a narrow gauge. Since the decision in January last, the works have been proceding with great rapidity.

We may now take a short glance at the principal features of the railway. The London entrance to the railway is not far from the west end of Oxford Street. Carriage and foot paths lead from the entrance to the station at Paddington, where there is a very capacious engine-house and carriage shed. Within a short distance of the commencement, the railroad passes under several handsome bridges: one of which, a continuation of the Westborne road, consists of seven arches. From the terminus a cutting commences, about a mile in length, and of an average depth of nine feet. Another cutting, of more than a mile in length, and averaging ten feet in length, carries the line through Wormwood Scrubs. About two miles from Paddington, the Thames Junction railway was intended to cross the Great Western.

Old Oak Common is crossed by an embankment half a mile long, and about twelve feet average depth. We next enter the deepest cutting on this portion of the line, through Acton parish, near Friar's Place, where it is about twenty-eight feet deep. Near to Old Oak Common, there is a private communication bridge across the cutting, with a handsome elliptical arch. After a short level, an excavation, two miles and a quarter in length, commences, through which the line is carried to Ealing: it is about fourteen feet in depth, chiefly through gravel and sandstone. This excavation is crossed by six bridges.

At about six-miles from London an embankment commences, three-quarters of a mile long, which leads to the Wharncliffe viaduct at Hanwell: its depth varies from about fifteen to thirty feet, and the road to Greenford is carried through it under a bridge. The viaduct, including the land-arches at each end, is about nine hundred feet in length. The main arches, eight in number, are nearly semi-elliptical, with a rise of seventeen feet, and seventy feet span. The piers at the springing of the arch are ten feet and a half thick, but wider at their base. This viaduct is one of the most beautiful parts of the whole railway.

An embankment is continued from the viaduct to the Uxbridge road, over which the railway is carried by a bridge of cast-iron. From thence the line passes on to Norwood, upon an embankment of nearly a mile in length, and varying from ten to twenty feet in height, until the natural level of the ground is again attained. From Norwood, through Southall-green to Hayes parish, the embankments and excavations are slight; but at the last-mentioned place an embankment commences, which, for a mile and a half, averages ten feet in depth. In the course of it occurs an occupation bridge, two skew bridges, over the Paddington and Grand Junction canals, and another over Yedding brook. From hence, for two miles and a half, the cuttings and embankments are slight. At West Drayton, about thirteen miles from town, the railroad again crosses the Uxbridge road, by a brick bridge.

An embankment nearly a mile long, and averaging fifteen feet in height, carries the line from West Drayton, over two streams at Thorney Road, and over the river Colne, by two bridges. On entering Iver parish, the line passes through a cutting, of more than a mile in length, and averaging ten feet in depth. We then pass through Langley Marsh parish, and near the village of Slough. From Slough to Maidenhead, the excavations vary from ten to five feet in depth, and the embankment from eight to thirty feet in height; while there are thirteen bridges, passing either over or under the railway. The line crosses the Great Western road at an angle of forty-five degrees, which requires one of those remarkable constructions, a *skew* bridge. Leaving the turnpike road, an embankment passes by another bridge, over the Taplow road, and the embankment grows deeper as it approaches the Thames, its maximum being about thirty-five feet.

From Paddington to Maidenhead, there are, besides the Wharncliffe viaduct, no less than twelve culverts and covered ways through embankments, and fifty-eight bridges passing over or under the line. The greatest inclination, or *gradient*, on this part of the line, is one foot in 1204, and the least one foot in 2640.

The Thames is crossed by a bridge of brick, consisting of two arches of 128 feet span each; some difficulty has been experienced with respect to this bridge, on account of the temporary settlement or derangement of the arches: indeed the eastern arch had to be rebuilt. Beyond the Thames occur a series of excavations and embankments; there is an excavation at Sonning, and an embankment at or beyond Reading; and the earth taken from the one was intended to be used in the other, but from some delay, a change had to be made in this respect. The middle portions of the railway are either still in progress, or are what engineers call *light*, that is, small embankments and cuttings are all that are necessary. We will therefore not dwell on this part of the line, but will quit it with the remark, that a railway diverges from this line to Cheltenham, at Swindon.

The part of which we shall lastly speak, viz., from Bath to Bristol, is by far the most difficult and gigantic of the whole. "It would be difficult, we believe," says Mr. Herapath, in the *Railway Magazine*, to which we have been indebted for many of the preceding details, "to instance another eleven miles of railway in the kingdom which display such a diversity of character, or greater natural obstacles to be overcome, than the line between Bristol and Bath, whilst the importance of these cities as termini is likewise unrivalled within the same distance out of the metropolis itself. Every variety of work which can be found on the largest railways (with the exception of crossing a moss,) is exhibited in the construction of this short line; and in some parts the works are of a very bold and imposing kind. Within the short space of eleven miles and a quarter, we have depôts, river, road, and occupation bridges, culverts, viaducts, tunnels, covered ways, retaining walls, lofty and extensive embankments, and deep cuttings in earth and solid rock. All these works are necessitated by the peculiar nature of the country, which is hilly and difficult. The only valley in the direction of the line is that through which the river Avon runs from Bath to Bristol; and this winds so much, and is in some parts so narrow, as to render it impracticable for the railway to follow its course for any distance."

The railroad crosses the Avon near Nesthaw Dam, and also near the depôt at Bath, keeping on the south side of it in the intervening distance: it occasionally touches the ground level, and is carried by means of tunnels and excavations through the hilly ridges, which run down nearly at right angles to the river, and by embankments and bridges over the intervening valleys and water courses. The cuttings and embankments nearly balance each other, the former being rather in excess, and amounting altogether to nearly one million cubic yards.

Proceeding from the terminus at Temple Meads, Bristol, the line is carried over a short viaduct to the harbour bridge, from which an embankment leads to the Feeder, over which a bridge is thrown, and another embankment leads to the Avon, over which a bridge of three stone arches is thrown. Proceeding onward, the line arrives at a perpendicular cutting in red sandstone, fifty feet deep and 170 yards long. This leads to the first tunnel, 330 yards long, thirty feet high, and thirty feet wide: this is hewn out of the hard rock, and supported without artificial masonry. On emerging from the tunnel, the line enters a valley, and shortly afterwards another tunnel, about 150 yards in length. There then occurs some deep cutting through solid rock, and a third tunnel, more than half a mile long. On emerging from this, the line skirts the river Avon on an embankment; and then ensues a cutting, half a mile long, and in some places seventy feet deep, through hard sandstone: the sides are nearly perpendicular, and the whole presents a stupendous appearance. There then ensues an embankment three-quarters of a mile long and thirty feet high, during which are two stone bridges and two culverts. This is succeeded by another cutting, and by two more short

embankments; after which comes a cutting, three-quarters of a mile long, and in some places forty feet deep, which leads to the Salford tunnel, 160 yards long.

Thence succeeds a very deep excavation,—then a high embankment nearly two miles long, passing over six bridges,—and then another cutting. Alternations of cutting and embanking follow until the line arrives at the Tiverton tunnel, 260 yards long. At about ten miles from Bristol is the Tiverton viaduct, half a mile in length. Another succession of cuttings and embankments brings the line to Bath.—The Box tunnel, excavated through hard stone, has already been alluded to.

The railroad was opened from London to Maidenhead on the 4th June, 1838; and from then to the 30th September, the number of passengers was 177,774, the receipts being in June, 6459*l.*, in July, 6913*l.*, in August, 7152*l.*, in September, 7579*l.* The velocity was never less than twenty-five miles per hour, and in many cases was above thirty miles. By the month of May in the past year the number of passengers had risen to about 1100 daily; the distance (still only to Maidenhead) being frequently performed in forty-eight minutes. In June, the receipts had amounted to 2000*l.* per week. In July, the railroad was opened nine miles further, to Twyford. During the Ascot races, one of the railway trains conveyed no less a number than 675 passengers, besides some carriages and horses. The daily number of passengers has since approached 3000.

In conclusion, we may say that this immense undertaking (which will cost more than five millions,) bids fair to be one of great importance in a commercial point of view, by bringing London and Ireland practically near each other, as well as in conveying colonial and other produce from Bristol to London.

LONDON AND GREENWICH RAILWAY.

This differs from every undertaking of the kind, in being raised on brick arches the whole distance. It was commenced in 1833, and connects London with the populous towns of Deptford and Greenwich, by a line which shortens the distance nearly one third. It commences south-east of London Bridge, and pursues nearly a straight line to the High Street of Deptford, whence it continues in a gentle curve to Greenwich, at which town there will shortly be a handsome terminus, about 200 yards from the church.

The rails are laid throughout on a viaduct composed of about 1000 arches, each twenty-two feet high, eighteen feet span, and twenty-five feet in width from side to side. This form of construction was rendered necessary by the number of streets over which the line had to be carried, with the traffic through which it would otherwise have greatly interfered. This difficulty might have been overcome by means of an embankment, with arches at the intersections of the streets, but the expense in that case would have been enormous, since the whole of the materials must have been brought from a distance, and the cost of the additional ground that must have been purchased would have been great, as embankments require to be very wide at the bottom. A parapet wall, about four feet high, is built at each edge of the railway; and lamps and milestones are placed at certain distances.

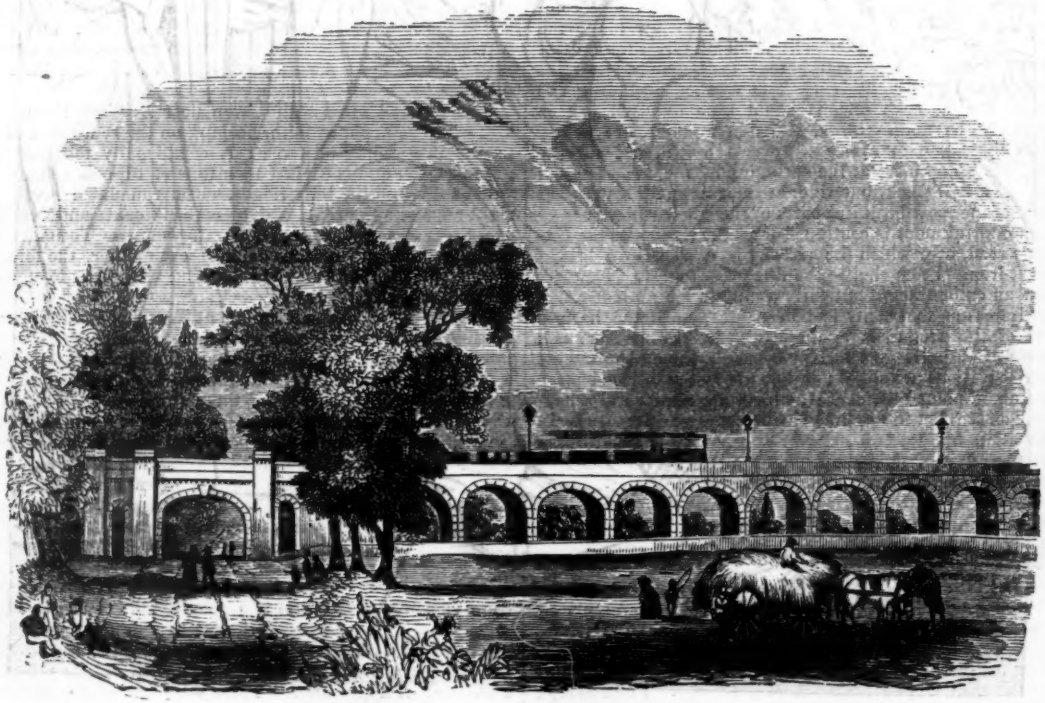
In the early part of 1836 a portion was opened about two miles and a quarter in length. By the end of the year the receipts averaged about 50*l.* per day. The original capital was 400,000*l.*, after which 130,000*l.* were procured on bonds, and in the beginning of 1837, the directors announced that 200,000*l.* more was required. About that period the weekly traffic was between thirty and forty thousand persons.

The blocks for carrying the rails on this railway, are principally of granite, and on these were placed cast-iron chairs. The iron rails weigh about fifty pounds the yard.

No railroad experiences so much the effect of a *holiday* as that from London to Greenwich. Ever since it has been opened the whole distance, it becomes one of the means of transit for the summer visitors from London to Greenwich. During Whitsun week, in the year 1839, the number of passengers was remarkably large: on the Monday, 35,332, receipts, 1227*l.*; Tuesday, 22,877, receipts, 784*l.*; Wednesday, 10,205, receipts, 343*l.*; Thursday, 4634, receipts, 117*l.*; Friday, 3372, receipts, 122*l.*; Saturday, 346*l.*,—making 2941*l.*

There is one circumstance which will always operate in keeping down, in some degree, the number of passengers upon this railway; we allude to the numerous steam-boats that ply every half-hour between London and Greenwich. At the same time it may be regarded as a striking instance of the extent of intercourse between the two places, that steam-boats go every half hour from London to Greenwich, and *vice versâ*, and that railroad trains proceed every *quarter* of an hour throughout the day in both directions.

This railroad, however, has a degree of importance given to it, by being the London terminus of the Croydon, and also of the Brighton Railway, of which one is finished, and the other is rapidly progressing.



VIEW OF THE GREENWICH RAILWAY.

LONDON; Published by JOHN W. PARKER, West Strand; and sold by all Booksellers.